REMARKS

This is a full and timely Response to the Final Office Action mailed June 22, 2001. Claims 1, 4-11, and 14-18 remain pending in the application. Of these, independent claims 1, 11, and 18 have been amended with this response. It is believed that the foregoing amendments present no new matter to the instant application. The Applicant respectfully requests reconsideration and allowance of the presently pending claims.

Claim Rejections Under 35 U.S.C. § 103(a)

1. Rejection of Claims 1, 11, and 18

a.) Statement of the Rejection

Claims 1, 11, and 18 have been rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over *Greene, et al.* (*"Greene,"* U.S. Patent Number 5,579,455 in view of *Sudarsky, et al.* (*"Sudarsky,"* U.S. Patent Number 6,088,035). Specifically, the rejection alleges:

> Greene et al. discloses creating a Z pyramid data structure (col. 5, lines 51 - 52), the z pyramid data structure comprising at least first and second levels, each level comprising a plurality of regions (col. 5, lines 51- 65), each region comprising subregions (col. 26, lines 38 - 39), each subregion corresponding to a single Z value (col. 26, lines 39 - 45), each region corresponding to a plurality of Z values of the region, wherein each subregion in the second level has a Z value that corresponds to a maximum Z value of a plurality of subregions in the first level (col. 26, lines 47 - 51), the logic comparing the minimum Z value of each primitive with the Z value of a region associated with the tested primitive to determine whether or not the tested primitive is fully occluded (col. 26, lines 61 - 67); if the tested primitive is not fully occluded, the logic determines whether or not any subregion of the region associated with the tested primitive is fully covered by the primitive, wherein if a subregion is fully covered by the tested primitive, then the logic determines whether or not the Z value of the covered subregion needs to be replaced with the maximum Z value of the tested primitive (col. 19, lines 44-49, FIG. 12); the logic of Greene determines whether the Z value of the covered subregion needs to be replaced with the maximum Z value of the tested primitive, the logic determines whether the maximum Z value of the tested primitive is less than the Z value (nearer than the current depth value) for the covered subregion, if the maximum Z value is less than the Z value for the covered subregion, then the Z value for the covered subregion is replaced with the maximum Z value (col. 19,

> lines 50-53); further Sudarsky discloses updating the potentially visible dynamic object list as previously hidden dynamic objects become visible, and hidden.

The Final Office Action then offers in a conclusory manner,

> It would have been obvious to one of ordinary skill in the art to incorporate Sudarsky's teaching into Greene's method for updating the occluded dynamic object during the time period (on the fly), providing an improved method for displaying graphics models which adapts visibility culling algorithms to dynamic scenes, and also minimizes the update overhead of the model that may be potentially visible to the user.

Applicant respectfully traverses this rejection.

b.) Summary of Applicant Arguments

The Applicant respectfully disagrees with the Final Office Action for at least the following reasons.

First, both *Greene* and *Sudarsky* fail to teach the claimed invention as hereby amended.

Second, the combination of *Greene* and *Sudarsky* is improper because the Office Action fails to state why it would have been obvious to combine the apparatus of *Greene* (a method that updates a Z pyramid after scan conversion) with the temporal bounding volumes of *Sudarsky* (a method that does not use a Z pyramid) to make the claimed invention. An Office Action, in order to formulate a valid and complete rejection under 35 U.S.C. § 103(a), must cite the specific teaching within the prior art that suggests a desirability to combine the references. In order for a claim to be properly rejected under 35 U.S.C. § 103, "[t]he PTO has the burden under section 103 to establish a *prima facie* case of obviousness. It can satisfy this burden only by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references." *In re Fine,* 837 F.2d 1071, 5 U.S.P.Q.2d 1596, 1600 (Fed. Cir. 1988). Accordingly, as a matter of law, the rejection in the present instance is improper.

Third, the Final Office Action rejections of claims 4-7, 9-11, and 14-18 citing the combinations of *Greene* and *Sudarsky* and the rejection of claim 8 citing the combination of *Greene* and *Sudarsky* in further view of *Greene* ('763) fail for at least the same reasons that the combination of *Greene* and *Sudarsky* fail. Stated another way, the cited combination fails to cure the underlying defects of *Greene* and *Sudarsky.* Consequently, the proposed

combination of *Greene* and *Sudarsky* fails to disclose, teach, or suggest all features of claims 4-7, 9-11, and 14-18. Furthermore, the proposed combination of *Greene* ('455), *Sudarsky,* and *Greene* ('763) fails to disclose, teach, or suggest all features of claim 8.

Applicant respectfully requests entry of the above arguments to the record to preserve these issues for a subsequent appeal of the Final Office Action's rejection of the pending claims.

c.) Applicant's Invention

Applicant's independent claims 1, 11, and 18 as amended describe a method and apparatus for occlusion testing primitives being processed in a graphics system and for updating a Z pyramid data structure used for occlusion testing on the fly. The apparatus comprises logic configured to create the Z pyramid data structure and to perform occlusion testing.

Preferably, the primitives are occlusion tested in a tiler component of the graphics system and the Z pyramid data structure is updated by the tiler component on the fly as primitives are being processed through the graphics system. The Z pyramid data structure may be stored in a Z pyramid memory element, which is in communication with the tiler. The Z pyramid memory element is periodically updated with pixel level Z values, *i.e.,* with Z values of primitives, which have been scan converted into screen coordinates corresponding to locations on the display monitor. In this way, the Z pyramid data structure can be updated on the fly and can be periodically updated with pixel level Z values to ensure accurate occlusion testing.

For convenience of analysis, Applicant's amended claim 1 is repeated below:

> 1. (Twice Amended) An apparatus for occlusion testing primitives being processed in a graphics system, each primitive having a minimum Z value and a maximum 7. value, the apparatus comprising:
>
> logic configured to create a Z pyramid data structure, the Z pyramid data structure comprising at least first and second levels, each level comprising a plurality of regions, each region comprising a plurality of subregions, each subregion corresponding to a single Z value, each region corresponding to a plurality of Z values and having a maximum region Z value corresponding to the greatest of the Z values of the region, wherein each subregion in the second level has a Z value that corresponds to a maximum Z value of a plurality of subregions in the first level, said logic comparing the minimum Z value of

each primitive with the Z value of a region associated with the tested primitive to determine whether the tested primitive is fully occluded, wherein when the tested primitive is not fully occluded, said logic determines whether any subregion of the region associated with the tested primitive is fully covered by the primitive, wherein when a subregion is fully covered by the tested primitive, then said logic determines whether the Z value of the covered subregion needs to be replaced with the maximum Z value of the tested primitive, wherein said logic to determines whether the Z value of the covered subregion needs to be replaced with the maximum Z value of the tested primitive by determining whether the maximum Z value of the tested primitive is less than the Z value for the covered subregion, wherein ***when the maximum Z value of the primitive is less than the Z value for the covered subregion,*** **then** ***the Z value for the covered subregion is replaced with the maximum Z value of the primitive as primitives are being processed through the graphics system.***

(*Emphasis Added.*)

Accordingly, Applicant's claim defines an apparatus for occlusion testing primitives being processed in a graphics system. A Z pyramid memory element is used to store a Z pyramid data structure that permits occlusion testing while primitives are being processed by the graphics system. The Z pyramid memory element is periodically updated with pixel level Z values, *i.e.,* with Z values of primitives, which have been scan converted into screen coordinates corresponding to locations on the display monitor. In this way, the Z pyramid data can be updated on the fly and can be periodically updated with pixel level Z values to ensure accurate occlusion testing. Notably, the other independent claims present in the case, claims 11 and 18, contain similar recitations regarding the processing of Z pyramid data.

d.) The *Greene et al.* ('455) Reference

Greene et al. apparently discloses a hierarchical Z-buffer scan-conversion algorithm that purports to do well on both (a) quickly rejecting most of the hidden geometry in a model, and (b) exploiting the spatial and temporal coherence of the images being generated. The method uses two hierarchical data structures an object-space octree and an image-space Z-pyramid, in order to accelerate scan conversion. The two hierarchical data structures make it possible to reject hidden geometry very rapidly while rendering visible geometry with the speed of scan conversion. For animation purposes, the algorithm is also able to exploit temporal coherence. The resulting method is well suited to models with high depth

complexity achieving significant increases in some cases compared to ordinary scan conversion.

In contrast to Applicant's claimed invention, in *Greene et al.'s* apparatus, once a determination is made that a cube contains a visible primitive, the visible primitive must be scan converted to the pixel level before the Z buffer can be updated and the Z pyramid can be reconstructed. With regard to scan conversion, *Greene et al.* only makes a provision for marking the rendered *(i.e.,* scan converted) primitives to avoid scan converting them more than once. (See Col. 5, lines 30-37).

e.) The Sudarsky Reference

Sudarsky apparently discloses a method for rendering a 3-dimensional graphics scene made up of a plurality of static and/or dynamic objects composed of geometrical elements. The method appears to predict a time period during which each of the dynamic objects are expected to remain occluded; generating a volume that contains the dynamic object; inserting the volume into a spatial data structure used by an occlusion technique; applying the occlusion culling technique so as to output sensitively render the scene, yet not rendering or updating the occluded dynamic object during the time period, provided the occlusion culling technique does not find the volume to be visible. In short, *Sudarsky* discloses a visibility algorithm that does not update a hierarchical Z buffer (Col. 2, line 64 - Col. 3, line 2; Col. 3, line 44 - Col. 4, line 12; Col. 4, line 61 - Col. 5, line 13).

In contrast to the Applicant's claimed invention, the temporal bounding volumes are calculated on the fly as opposed to the Z pyramid calculations. In this way, *Sudarsky* assures compatibility with interactive applications in which this information is not available in advance, such as simulations, games, and virtual reality.

f.) Discussion of the Rejection

In order for a claim to be properly rejected under 35 U.S.C. §103, the combined teachings of the prior art references must suggest all features of the claimed invention to one of ordinary skill in the art. See, *e.g., In Re Dow Chemical,* 5 U.S.P.Q.2d 1529, 1531 (Fed. Cir. 1988), and *In re Kelley,* 208 U.S.P.Q.2d 871, 881 (C.C.P.A. 1981). Applicants submit for the following reasons that the cited combination fails to show or support all of the elements of claims 1, 11, and 18 as discussed below.

The *Greene et al.* patent ('455) cited by the Final Office Action appears to be directed to the same invention that is described in the article by *Greene et al.* discussed in the "Background of the Invention" in the present application. Both the article and the '455 patent disclose utilizing cubes to perform the Z-pyramid comparison tests and performing the Z comparison tests beginning at the top of the pyramid and moving downwards towards the bottom of the pyramid until a determination is made that a cube is either fully occluded or it is determined to be at least partially visible.

In essence, in *Greene et al.,* once the Z pyramid has been constructed, the Z values for the primitives making up the faces of the cubes are compared beginning at the highest level of the pyramid and working down towards the base of the pyramid. For each primitive of a face of a cube, the minimum Z value of the primitive is tested against the levels of the pyramid in a top-to-bottom sequence. If the minimum Z value for the primitive is greater than the pyramid Z value, then the primitive is fully occluded. If all of the primitives making up all of the faces of the cube are occluded, the cube is occluded and can be discarded. If not, the process continues to the next level of the pyramid. At each level of the pyramid, the process is performed until a determination is made that the cube is either fully occluded or until the process reaches the level in the Z pyramid at which a primitive is found to be at least partially visible.

As stated in the "Background of the Invention" in the present application, the approach described in *Greene et al.* enables a plurality of primitives to be simultaneously tested instead of individually testing each primitive. However, the approach of *Greene et al.* does not make any provision for updating the Z pyramid "on the fly," *i.e., **as primitives are being processed through the graphics pipeline**.* Once a determination is made that a cube contains a visible primitive, the visible primitive must be scan converted to the pixel level before the Z buffer can be updated and the Z pyramid can be reconstructed. *Greene et al.* only makes a provision for marking the rendered (*i.e.,* scan converted) primitives to avoid scan converting them more than once. (See Col. 5, lines 30-37). All of the algorithms described in *Greene et al.* require that each face of each cube be scan converted in order to determine whether the cube is hidden. Therefore, the algorithms inherently require that scan conversion be performed before the Z pyramid can be updated.

In contrast, the present invention enables the Z buffer to be updated and the Z pyramid to be reconstructed on the fly as primitives are processed prior to scan conversion.

Independent claims 1, 11 and 18 have been amended to more accurately point out this feature of updating the Z pyramid on the fly. In accordance with the present invention, as described in independent claims 1, 11 and 18, each region corresponds to a plurality of Z values and has a maximum region Z value, which corresponds to the largest Z value of the region. The minimum Z value of each primitive is compared with the Z value of a region associated with the primitive to determine whether or not the primitive is fully occluded. When the primitive is not fully occluded, then a determination is made as to whether any subregion of the region associated with the primitive is fully covered by the primitive. When a subregion is fully covered by the primitive, then the logic determines whether the Z value of the covered subregion needs to be replaced with the maximum Z value of the tested primitive. If so, the Z pyramid is updated accordingly. Thus, the Z pyramid is updated on the fly, rather than waiting until primitives have been scan converted. This, in turn, expedites the Z comparison tests and improves the overall performance of the computer graphics display system.

In order to overcome the deficiency in the *Greene et al.* reference, the Final Office Action offers *Sudarsky* for the proposition that *Sudarsky* teaches updating Z pyramid data values on the fly. However, *Sudarsky's* visibility algorithm does not use a hierarchical Z buffer (Col. 2, line 64 - Col. 3, line 2; Col. 3, line 44 - Col. 4, line 12; Col. 4, line 61 - Col. 5, line 13). *Sudarsky* discloses a method for rendering a 3-dimensional graphics scene made up of a plurality of static and/or dynamic objects composed of geometrical elements. *Sudarsky's* method assures compatibility with interactive applications in which this information is not available in advance, such as simulations, games, and virtual reality by predicting a time period during which each of the dynamic objects are expected to remain occluded and generating a temporal bounding volume that contains the dynamic object.

In contrast to the Applicant's claimed invention, the temporal bounding volumes are calculated on the fly as opposed to the Z pyramid data values. In this way, *Sudarsky* assures compatibility with interactive applications in which this information is not available in advance, such as simulations, games, and virtual reality.

As identified above in reference to independent claim 1, neither *Greene et al.* nor *Sudarsky* disclose, teach or suggest ***the Z value for the covered subregion is replaced with the maximum Z value of the primitive as primitives are being processed through the graphics system*** as defined in Applicant's independent claims. In that *Sudarsky* does not remedy this deficiency of the *Greene et al.* reference, Applicant respectfully submits that

independent claim 1 patently defines over the prior art of record and is allowable. Since claim 1 is allowable, as argued above, pending dependent claims 4-10 are allowable as a matter of law since they contain all features of their respective independent claim. *In re Fine,* 5 U.S.P.Q.2d 1596, 1600 (Fed. Cir. 1988).

Applicant respectfully submits that independent claim 11 contains the same elements that render claim 1 patentable over the prior art of record. Consequently, claim 11 and its pending dependent claims (claims 14-17) are allowable for at least the same reasons as independent claim 11. For convenience, Applicant's independent claim 11 is repeated below.

> 11. (Twice Amended) A method for occlusion testing primitives in a graphics system, each primitive having a minimum Z value and a maximum Z value, the method comprising the steps of:
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> generating a Z pyramid data structure, the Z pyramid data structure comprising at least first and second levels, each level comprising a plurality of regions, each region comprising a plurality of subregions, each subregion corresponding to a single Z value, each region corresponding to a plurality of Z values and having a maximum region Z value corresponding to the greatest of the Z values of the region, wherein each subregion in the second level has a Z value that corresponds to a maximum Z value of a plurality of subregions in the first level;
>
> comparing the minimum Z value of each primitive with the Z value of a region associated with the tested primitive to determine whether the tested primitive is fully occluded;
>
> when the tested primitive is not fully occluded, determining whether or not any subregion of the region associated with the tested primitive is fully covered by the primitive;
>
> when a subregion is fully covered by the tested primitive, determining whether or not the Z value of the covered subregion needs to be replaced with the maximum Z value of the tested primitive by determining whether or not the maximum Z value of the tested primitive is less than the Z value for the covered subregion; and
>
> ***when the maximum Z value of the primitive is less than the Z value for the covered subregion, replacing the Z value for the subregion with the maximum Z value of the primitive as primitives are being processed through the graphics system.***

(Emphasis Added.)

Applicant respectfully submits that independent claim 18 contains the same elements that render claims 1 and 11 patentable over the prior art of record. Consequently,

independent claim 18 is allowable for at least the same reasons as independent claims 1 and 11. For convenience, Applicant's independent claim 18 is repeated below:

> 18. (Twice Amended) An apparatus for occlusion testing primitives being processed in a graphics system, each primitive having a minimum Z value and a maximum Z value, the apparatus comprising:
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> means for creating a Z pyramid data structure, the Z pyramid data structure comprising at least first and second levels, each level comprising a plurality of regions, each region comprising a plurality of subregions, each subregion corresponding to a single Z value, each region corresponding to a plurality of Z values and having a maximum region Z value corresponding to the greatest of the Z values of the region, wherein each subregion in the second level has a Z value that corresponds to a maximum Z value of a plurality of subregions in the first level; and
>
> means for comparing the minimum Z value of each primitive with the Z value of a region associated with the tested primitive to determine whether the tested primitive is fully occluded, wherein if a determination is made that the tested primitive is not fully occluded, said comparing means determines whether any subregion of the region associated with the tested primitive is fully covered by the primitive, wherein when that a subregion is fully covered by the tested primitive, then said comparing means determines whether the Z value of the covered subregion needs to be replaced with the maximum Z value of the tested primitive by determining whether the maximum Z value of the tested primitive is less than the Z value for the covered subregion, wherein ***when said comparing means determines that the maximum Z value of the primitive is less than the Z value for the covered subregion, then said comparing means replaces the Z value for the subregion with the maximum Z value of the primitive as primitives are being processed through the graphics system.***

(Emphasis Added.)

2. Rejection of Claims 4 and 14

a.) Statement of the Rejection

Claims 4 and 14 have been rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over *Greene, et al.* in view of *Sudarsky*. Specifically, the rejection alleges:

> Greene et al. discloses the logic maintains a coverage mask for each subregion of the level Z pyramid data structure, each coverage mask comprising a bit for each subregion of the level Z pyramid data associated with the coverage mask, wherein the logic determines that the maximum Z value of the primitive is less than the value (nearer than the nearest depth) for the covered subregion,

> a bit in the coverage mask associated with the covered subregion is set (col. 17, lines 26-32).

b.) Discussion of the Rejection

Even if *Greene* teaches the alleged coverage mask, the addition of *Sudarsky* fails to cure the aforementioned defects of *Greene.* Consequently, the proposed combination fails to disclose, teach, or suggest all features of claims 4 and 14. In that Applicant has offered sufficient grounds for the patentability of independent claims 1 and 11 and claims 4 and 14 depend therefrom, respectively, Applicant submits that the rejection of claims 4 and 14 have been overcome and/or rendered moot.

3. Rejection of Claims 5 and 15

a.) Statement of the Rejection

Claims 5 and 15 have been rejected under 35 U.S.C. § 103(a) as purportedly being unpatentable over *Greene, et al.* in view of *Sudarsky.* Specifically, the rejection alleges:

> Greene et al. discloses all coverage mask bits corresponding to the subregions of a particular region have been set in the coverage mask associated with the first level of the Z pyramid data, a bit is set for the corresponding region in the coverage mask associated with the second level in the Z pyramid data (col. 18, lines 9-19).

b.) Discussion of the Rejection

Even if *Greene* teaches the alleged coverage mask, the addition of *Sudarsky* fails to cure the aforementioned defects of *Greene.* Consequently, the proposed combination fails to disclose, teach, or suggest all features of claims 5 and 15. In that Applicants have offered sufficient grounds for the patentability of independent claims 1 and 11 and claims 5 and 15 depend therefrom, respectively, Applicants submit that the rejection of claims 5 and 15 have been overcome and/or rendered moot.

4. Rejection of Claims 6 and 16

a.) Statement of the Rejection

Claims 6 and 16 have been rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over *Greene, et al.* in view of *Sudarsky.* Specifically, the rejection alleges:

> Greene et al. discloses the bits in the coverage mask have been set for a particular region in the coverage mask, the logic

replaces the maximum Z value for the particular region with the maximum Z value of the subregions associated with the particular region (FIG. 19A).

b.) Discussion of the Rejection

Even if *Greene* teaches the alleged coverage mask, the addition of *Sudarsky* fails to cure the aforementioned defects of *Greene.* Consequently, the proposed combination fails to disclose, teach, or suggest all features of claims 6 and 16. In that Applicant has offered sufficient grounds for the patentability of independent claims 1 and 11 and claims 6 and 16 depend therefrom, respectively, Applicant submits that the rejection of claims 6 and 16 have been overcome and/or rendered moot.

5. Rejection of Claims 7 and 17

a.) Statement of the Rejection

Claims 7 and 17 have been rejected under 35 U.S.C. § 103(a) as purportedly being unpatentable over *Greene, et al.* in view of *Sudarsky.* Specifically, the rejection alleges: "Greene et al. discloses the logic sets the corresponding bit in the coverage mask for a next level up in the Z pyramid (col. 10, lines 8-67)."

b.) Discussion of the Rejection

Even if *Greene* teaches the alleged coverage mask, the addition of *Sudarsky* fails to cure the aforementioned defects of *Greene.* Consequently, the proposed combination fails to disclose, teach, or suggest all features of claims 7 and 17. In that Applicant has offered sufficient grounds for the patentability of independent claims 1 and 11 and claims 7 and 17 depend therefrom, respectively, Applicant submits that the rejection of claims 7 and 17 have been overcome and/or rendered moot.

6. Rejection of Claim 9

a.) Statement of the Rejection

Claim 9 has been rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over *Greene, et al.* in view of *Sudarsky.* Specifically, the rejection alleges: "Greene et al. discloses the tiler being in communication with a Z pyramid memory element, the Z pyramid memory storing the Z pyramid data (col. 28, lines 1-24)."

b.) Discussion of the Rejection

Even if *Greene* teaches the alleged tiler, the addition of *Sudarsky* fails to cure the aforementioned defects of *Greene*. Consequently, the proposed combination fails to disclose, teach, or suggest all features of claim 9. In that Applicant has offered sufficient grounds for the patentability of independent claim 1 and claim 9 depends therefrom, Applicant submits that the rejection of claim 9 has been overcome and/or rendered moot.

7. Rejection of Claim 10

a.) Statement of the Rejection

Claim 10 has been rejected under 35 U.S.C. § 103(a) as purportedly being unpatentable over *Greene, et al.* in view of *Sudarsky*. Specifically, the rejection alleges:

> Greene et al. discloses the Z pyramid memory is periodically updated with the pixel Z values corresponding to Z values of primitives which have been scan converted into screen coordinates, wherein the pixel level Z (values) are used by the tiler (quadrant) to periodically reconstruct the Z pyramid data (col. 5, Line 60 through col. 6, line 36).

b.) Discussion of the Rejection

Even if *Greene* teaches the alleged Z pyramid memory, the addition of *Sudarsky* fails to cure the aforementioned defects of *Greene*. Consequently, the proposed combination fails to disclose, teach, or suggest all features of claim 10. In that Applicant has hereinabove offered sufficient grounds for the patentability of independent claim 1 and claim 10 depends therefrom, Applicant submits that the rejection of claim 10 has been overcome and/or rendered moot.

8. Rejection of Claim 8

a.) Statement of the Rejection

Claim 8 has been rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over *Greene, et al.* in view of *Sudarsky* in further view of *Greene et al. (U.S.* Patent 5,600,763). Specifically, the rejection alleges: "Greene et al. ('763) discloses the primitives) are occlusion tested in a tiler component of the graphics wherein the Z pyramid data is updated by the tiler on the fly as the primitives are being processed through the graphics system (col. 6, lines 29-40)." The Final Office Action Rejection then concludes, "It would have been obvious to one of ordinary skill in the art to include a "tiling pass" as taught by

Greene, because tiling pass (very rapidly) has culled most of the hidden polygons it could improve in updating or inserting the remaining polygons into the quadtree (Z pyramid)." Applicant respectfully traverses this application of the '763 patent.

b.) Discussion of the Rejection

The *Greene et al.* reference (the '763 patent) is directed to a method to prevent aliasing in a color display containing complex geometrical shapes. In this regard, the '763 patent refers to and includes by reference the entire contents of *Greene et al's* '455 patent. The portion of the '763 patent that the Final Office Action relies on is repeated below for convenience.

> FIG. 5B is used to illustrate quadtree subdivision of an image plane driven by the complexity of visible geometry, which is similar to the subdivision performed by the antialiased rendering algorithm of the present invention described below during a "tiling pass." As illustrated, the example shows 5 levels of subdivisions A-E, i.e., until no more than two primitives are visible in a quadtree cell Q. In the "tiling pass" of the algorithm of the present invention, the quadtree cells are subdivided whenever more than some fixed number of primitives, e.g. 10, are determined to be visible.

Applicant respectfully submits that the relied upon reference does not disclose, teach, or suggest to one skilled in the art how to make the Applicant's claimed invention as recited in independent claim 1. Consequently, the proposed combination fails to disclose, teach, or suggest all features of dependent claim 8, which depends therefrom. In that Applicant has hereinabove offered sufficient grounds for the patentability of independent claim 1 and claim 8 depends therefrom, Applicant submits that the rejection of claim 8 has been overcome and/or rendered moot.

9. Office Action Does Not Cite Motivation to Modify *Greene et al.'s* ('455) System

In connection with the above-discussion, yet forming a separate and independent basis for patentability, the Final Office Action failed to cite a proper teaching, suggestion or motivation, to alter the *Greene et al.* system in such a way as to render the presently-claimed invention unpatentable.

As acknowledged by the Court of Appeals for the Federal Circuit, the U.S. Patent and Trademark Office ("USPTO") has the burden under section 103 to establish a *prima facie* case of obviousness by showing some objective teaching in the prior art or generally available

knowledge of one of ordinary skill in the art that would lead that individual to the claimed invention. See *In re Fine,* 837, F.2d 1071, 5 U.S.P.Q.2d 1596, 1598 (Fed. Cir. 1988). Accordingly, to make a *prima facie* case for obviousness, there must be some prior art teaching or established knowledge that would suggest to a person having ordinary skill in the pertinent art to fill the voids apparent in the applied reference. It is respectfully asserted that no such *prima facie* case has been made in the outstanding Office action.

In this regard, the Final Office Action has wholly failed to cite a proper suggestion, teaching, or other motivation to modify the teachings of *Greene* in such a way as to disclose the Applicant's presently-claimed invention. Instead, the Final Office Action has merely stated, in conclusory fashion, that

> it would have been obvious to a person of ordinary skill in the art at the time the invention was made to incorporate Sudarsky's teaching into Greene's method for updating occluded dynamic object during the time period (on the fly), providing an improved method for displaying graphics models which adapts visibility culling algorithms to dynamic scenes.

There is nothing in *Greene* or in *Sudarsky* that suggest that *Greene's* hierarchical Z-buffer scan-conversion algorithm that marks the rendered *(i.e.,* scan converted) primitives to avoid scan converting them more than once would be applicable to a graphics system that performs Z pyramid calculations as primitives are being processed by the system as in the present independent claims. Furthermore, there is no suggestion in *Sudarsky,* which apparently teaches temporal bounding volumes that are calculated on the fly might be adapted to perform Z pyramid calculations. Significantly, *Sudarsky* does not use a Z pyramid as recited in the present independent claims. Absent such motivation, the combination of *Greene* and *Sudarsky* is improper. Moreover, there is no suggestion in *Greene et al.* ('763) that the anti-aliasing method might be adapted to perform Z pyramid calculations as recited in the pending independent claims.

An Applicant's disclosure or specification cannot be used as a road map for forming a § 103(a) rejection. It is well settled law that in order to properly support an obviousness rejection under 35 U.S.C. § 103(a), there must have been some teaching *in the prior art* to suggest to one skilled in the art that the claimed invention would have been obvious. *W. L. Gore & Associates, Inc. v. Garlock Thomas, Inc.,* 721 F.2d 1540, 1551 (Fed. Cir. 1983). More significantly,

> "The .consistent criteria for determination of obviousness is whether the prior art would have suggested to one of ordinary skill in the art that this [invention] should be carried out and would have a reasonable likelihood of success, viewed in light of the prior art . ..." **Both** ***the suggestion and the expectation of success must be founded in the prior art, not in the applicants' disclosure...*** **In** determining whether such a suggestion can fairly be gleaned from the prior art, the full field of the invention must be considered; for the person of ordinary skill in the art is charged with knowledge of the entire body of technological literature, including that which might lead away from the claimed invention."

(Emphasis added.) In re Dow Chemical Company, 837 F.2d 469, 473 (Fed. Cir. 1988).

The Federal Circuit has repeatedly stated, "the inquiry is not whether each element existed in the prior art, but whether the prior art made obvious the invention as a whole for which patentability is claimed." *Hartness International, Inc. v. Simplimatic Engineering Co.,* 819 F.2d 1100, 1108, 2 U.S.P.Q.2d 1826 (Fed. Cir. 1987). "The mere fact that the prior art could be so modified would not have made the modification obvious unless the prior art suggested the desirability of the modification." *In re, Gordon,* 733 F.2d 900, 221 U.S.P.Q. 1125, 1127 (Fed. Cir. 1984). "Modification unwarranted by the disclosure of a reference is improper." *Carl Schenck, A. G, v. Nortron Corp.,* 713 F.2d 782, 218 U.S.P.Q. 698, 702 (Fed. Cir. 1983). In this regard, "[t]he mere fact that the prior art may be modified in the manner suggested by the [Office action] does not make the modification obvious unless the prior art suggested the desirability of the modification." *In re Fritch,* 972 F.2d 1260, 1266, 23 U.S.P.Q.2d 1780 (Fed Cir. 1992).

Irrespective of the clear lack of motivation to combine the *Greene* and *Sudarsky* references, Applicant asserts that the rejection is improper because, even if the teachings of the two references were properly combinable, such combination would not result in the Applicant's claimed invention as amended above. *Greene* and *Sudarsky* simply fail to teach, disclose or suggest ***when the maximum Z value of the primitive is less than the Z value for the covered subregion,*** **then** ***the Z value for the covered subregion is replaced with the maximum Z value of the primitive as primitives are being processed through the graphics system*** as found in the amended independent claims 1, 11, and 18. Consequently, the combination of *Greene* and *Sudarsky* simply would not result in Applicant's claimed invention as amended above.

In summary, it is the Applicant's position that a *prima facie* case for obviousness has not been made against Applicant's independent claims 1, 11, and 18. In addition, as a result of their dependence from independent claims l and 11, a *prima facie* case for obviousness has not been made against Applicant's claims 4 through 10 and claims 14 through 17, which depend from claims 1 and 11, respectively. Therefore, it is respectfully submitted that each of the pending claims 1, 4-11, and 14-18 is allowable over the cited prior art and that the rejection of these claims should be withdrawn.

CONCLUSION

In summary, it is respectfully submitted that claims 1, 4-11, and 14-18 define an invention that embodies a distinct advance in the art not rendered obvious by the cited art of record. Accordingly, a Notice of Allowability would be appreciated and is therefore respectfully solicited. Should the Examiner have any questions regarding this response, the Examiner is cordially invited to telephone the undersigned attorney.

Respectfully submitted,

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APPENDIX - AMENDMENTS TO THE CLAIMS

The following claims have been amended by deleting the bracketed (" [ ] ") text and adding the underlined ("___") text.

1. (Twice Amended) An apparatus for occlusion testing primitives being processed in a graphics system, each primitive having a minimum Z value and a maximum Z value, the apparatus comprising:

logic configured to create a Z pyramid data structure, the Z pyramid data structure comprising at least first and second levels, each level comprising a plurality of regions, each region comprising a plurality of subregions, each subregion corresponding to a single Z value, each region corresponding to a plurality of Z values and having a maximum region Z value corresponding to the greatest of the Z values of the region, wherein each subregion in the second level has a Z value that corresponds to a maximum Z value of a plurality of subregions in the first level, said logic comparing the minimum Z value of each primitive with the Z value of a region associated with the tested primitive to determine whether [or not] the tested primitive is fully occluded, wherein [if a determination is made that] when the tested primitive is not fully occluded, said logic determines whether [or not] any subregion of the region associated with the tested primitive is fully covered by the primitive, wherein [if said logic determines that] when a subregion is fully covered by the tested primitive, then said logic determines whether [or not] the Z value of the covered subregion needs to be replaced with the maximum Z value of the tested primitive, wherein said logic to determines whether the Z value of the covered subregion needs to be replaced with the maximum Z value of the tested primitive by determining whether [or not] the maximum Z value of the tested primitive is less than the Z value for the covered subregion, wherein [if said logic determines that] when the maximum Z value of the primitive is less than the Z value for the covered subregion, then the Z value for the covered subregion is replaced with the maximum Z value of the primitive as primitives are being processed through the graphics system.

11. (Twice Amended) A method for occlusion testing primitives in a graphics system, each primitive having a minimum Z value and a maximum Z value, the method comprising the steps of:

generating a Z pyramid data structure, the Z pyramid data structure comprising at least first and second levels, each level comprising a plurality of regions, each region comprising a plurality of subregions, each subregion corresponding to a single Z value, each region corresponding to a plurality of Z values and having a maximum region Z value corresponding to the greatest of the Z values of the region, wherein each subregion in the second level has a Z value that corresponds to a maximum Z value of a plurality of subregions in the first level;

comparing the minimum Z value of each primitive with the Z value of a region associated with the tested primitive to determine whether [or not] the tested primitive is fully occluded;

[if a determination is made that] when the tested primitive is not fully occluded, determining whether or not any subregion of the region associated with the tested primitive is fully covered by the primitive;

[if a determination is made that] when a subregion is fully covered by the tested primitive, determining whether or not the Z value of the covered subregion needs to be replaced with the maximum Z value of the tested primitive by determining whether or not the maximum Z value of the tested primitive is less than the Z value for the covered subregion; and

[if a determination is made that] when the maximum Z value of the primitive is less than the Z value for the covered subregion, replacing the Z value for the subregion with the maximum Z value of the primitive as primitives are being processed through the graphics system.

18. (Twice Amended) An apparatus for occlusion testing primitives being processed in a graphics system, each primitive having a minimum Z value and a maximum Z value, the apparatus comprising:

means for creating a Z pyramid data structure, the Z pyramid data structure comprising at least first and second levels, each level comprising a plurality of regions, each region comprising a plurality of subregions, each subregion corresponding to a single Z value, each region corresponding to a plurality of Z values and having a maximum region Z value corresponding to the greatest of the Z values of the region, wherein each subregion in the second level has a Z value that corresponds to a maximum Z value of a plurality of subregions in the first level; and means for comparing the minimum Z value of each primitive with the Z value of a region associated with the tested primitive to determine whether [or not] the tested primitive is fully occluded, wherein if a determination is made that the tested primitive is not fully occluded, said comparing means determines whether [or not] any subregion of the region associated with the tested primitive is fully covered by the primitive, wherein [if said comparing means determines] <u>when</u> that a subregion is fully covered by the tested primitive, then said comparing means determines whether [or not] the Z value of the covered subregion needs to be replaced with the maximum Z value of the tested primitive by determining whether [or not] the maximum Z value of the tested primitive is less than the Z value for the covered subregion, wherein [if] <u>when</u> said comparing means determines that the maximum Z value of the primitive is less than the Z value for the covered subregion, then said comparing means replaces the Z value for the subregion with the maximum Z value of the primitive as <u>primitives are being processed through the graphics system</u>.